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EPITAXIAL GROWTH OF GOLD FILMS UNDER ION IRRADIATION

BYKOV, YU. V., GUSEVA, M. B., KEVEDO, KH., and ABDRASHITOVA, D. KH.

[Abstract] Nucleation and growth of gold films on the surface of ionic crystals was studied, of particular interest being the effect of ion irradiation either during or before film condensation from the vapor phase. Gold films were deposited on (100)-wafers of NaCl crystals under vacuum ($1 \cdot 10^{-6}$ torr) and checked for continuity by the optical interference method. A structural analysis under an electron microscope indicated an appreciable orientation effect of both modes of ion irradiation. According to the results, simultaneous ion irradiation and condensation facilitates epitaxial growth by lowering the necessary temperature and stimulating oriented nucleation so as to yield a higher concentration of centers at earlier stages of the process. Prior ion irradiation requires a flux of much higher density and energy for producing the same high particle concentration of $10^{12}/cm^2$ in a film. While a complete unidirectional orientation parallel to 100 Au 100 NaCl results from simultaneous irradiation, moreover, orientation in also several other directions results from prior irradiation. These findings are attributed to the structure of point defects formed by an ion flux and the kinetics of particle diffusion, to a charging of the substrate, and to stimulation or inhibition of oriented growth of particularly bounded microcrystals. Figures 4, references 4: 3 Russian, 1 Western.

EXAMINATION OF EPITAXIAL HETEROSTRUCTURES ON GaAs UNDER A RASTER-TYPE ELECTRON MICROSCOPE OPERATING IN THE CATHODOLUMINESCENCE MODE

GOVORKOV, A. V. and DRUZHININA, L. V., State Scientific Research and Design Institute of the Rare-Metals Industry

[Abstract] A raster-type JSM-2 electron microscope with a cathodoluminescence attachment was used for examination of epitaxial heterostructures on GaAs. The cathodoluminescence radiation was collected by a reflecting objective, focused on the inlet aperture of a monochromator behind the microscope tube, and recorded with a photomultiplier through a germanium photodiode. Epitaxial layers and multilayer specimens of GaAs-GaSb solid solutions were built up, considering that the respective lattice parameters of

of these two compounds differ more than those of any other $A^{III}B^V$ pair. The intensity of cathodoluminescence was found to be lower adjacent to heterojunctions and to be decreasing periodically in built up layers so as to yield a mesh of dark fringes. The latter effect is attributed to a multilevel mesh of incompatibility dislocation. In regions of high defect concentration around dislocations there form centers of nonradiative recombination. The nature of these phenomena has not been quite explained. There also form, however, oblique dislocations in such $GaAs_xSb_{1-x}$ layers which can be revealed by chemical etching. Figures 3; references: 3 Western.

MECHANISM OF EPITAXIAL ORIENTATION

VLASOV, V. P., DISTLER, G. I., and KANEVSKIY, V. M., Institute of Crystallography imeni A. V. Shubnikov, USSR Academy of Sciences

[Abstract] The mechanism of epitaxial orientation was studied on the model system of triglycine sulfate and silver chloride, considering the distinct domain structure of the former and extremely high sensitivity of oriented coalescence of the latter to the electrical relief of the substrate. The fundamental atomic structure of crystalline substrates was eliminated as a possible factor affecting the orientation process by the use of amorphous selenium interlayers. TGS crystals for this experiment were grown synthetically by the temperature dropping method. Selenium was deposited by vacuum evaporation from a tungsten coil and silver chloride was deposited from a molybdenum vessel, with the TGS crystals at 290 K. The kinetics of structure formation and the orientation mechanism were examined under an electron microscope, with the AgCl layer built up to 200 Å thickness on continuous 55-200 Å thick selenium interlayers. The results of this study suggest that the selective interaction between linear components of the reticulate electrically active structure determines the orientation effects during epitaxial growth, at the crystal-substrate interface as well as on the other side of amorphous interlayers. Figures 2; references 24: 10 Russian, 14 Western.

PHOTOELECTRIC CHARACTERISTICS OF GaP PIN-DIODES

NIKOLAYEV, YU. N. and TARASOV, V. M.

[Abstract] The photosensitivity spectrum of GaP diodes is characterized by
an exponential rise and by high levels under a forward bias. An experimental
study of these characteristics was made on such diodes having the n-region
doped with tellurium and oxygen and the p-region doped with zinc. A modu-
lated light beam parallel to the plane of their p-n junctions illuminated
these diodes. The photocurrent, as a function of the bias voltage and as a
function of the incident quantum energy, was measured with the aid of a
synchronous detector. An analysis of the results indicates the presence of
a large compensated i-region containing oxygen atoms and having n-type con-
ductivity. Most of the voltage drop under a positive bias across the p-n
junction occurs across this region and the photocurrent here, proportional
to the voltage, is opposite in direction to the short-circuit photocurrent.
A photoconduction signal in this region is one or two orders of magnitude
larger than a signal under a reverse bias, which makes such diodes with a
compensated i-region very suitable as photoresistors. Figures 2; references
9: 2 Russian, 7 Western.

INTERACTION OF MODES IN A GAS LASER WITH IDENTICAL DEGENERACY OF THE
ENERGY LEVELS OF THE WORKING TRANSITION

GONCHUKOV, S. A., YERMACHENKO, V. M., PETROVSKIY, V. N. and PROTSENKO, YE. D.

[Abstract] Stimulated emission of two orthogonally polarized modes in a gas
laser is considered and it is shown that the strong coupling between these
modes when the moments of the energy levels of the working transition are
$j_b = 1$, $j_a = 2$ can be completely eliminated when the working levels are
equally degenerate. Attenuation of the coupling between the fields of the
interacting modes through the magnetic sublevels of the excited atoms on
the transition $j_b = j_a = 1$ eliminates the critical frequency regardless of
the nature of line broadening, thus enabling continuous control of inter-
mode spacing within the limits of the lasing band. Experiments were done
with a helium-neon laser with emission on the $3s_2$-$3p_2$ transition ($\lambda_1 =$
3.3913 μm), giving the proper combination of moments. The results confirm
the conclusion that two-mode lasing action occurs throughout the entire
range of intermode spacing ω_{12} from 0 to c/2L, where c is the speed of
light and L is the distance between laser mirrors. This range is consider-
ably extended by using a waveguide laser: a range of 750 MHz has been
attained, and optimization of laser parameters should make it feasible to
reach a width considerably exceeding 1000 MHz. Figures 3, references 11:
8 Russian, 3 Western.

SPECIFICS OF THE SPECTRAL KINETICS OF LASERS BASED ON POLYATOMIC ORGANIC
MOLECULES

GRUZINSKIY, V. V., DAVYDOV, S. V.

[Abstract] A theoretical analysis is presented of the influence of the
spectral characteristics of lasing media, changes in the population of
energy levels, pumping conditions, resonator parameters and many other
factors on the nature of change of wavelength at the maximum of the genera-
tion band and of the entire band of radiation with time. Uniform expansion

of spectral absorption and emission bands is assumed. The calculation model used allows good description of the spectral and kinetic characteristics of the radiation over a broad range of pumping lengths. The calculated change in wavelength of the generation maximum as a function of time is confirmed by numerical calculations using more precise kinetic equations. The behavior of the spectrum of radiation as time passes is quite sensitive to changes in the spectral parameters of the active medium and the pumping conditions. Figures 4; references 22: 14 Russian, 8 Western.

OPTICAL MEASUREMENTS OF THE TEMPERATURE UPON LASER HEATING OF A SOLID SURFACE

DLUGUNOBICH, V. A., SNOPKO, V. N.

[Abstract] Measurements were performed of the surface temperature of several dielectrics (glass, quartz, hetinax, textolite) and graphite exposed to the focused radiation of a CO_2 continuous laser of up to 200 W. The temperature of the specimens was measured by means of a 4-channel spectrometer. When glass was irradiated at $1.5 \cdot 10^2$--$2 \cdot 10^3$ W/cm^2, a flame develops, increasing the effective radiation capacity. This increase is probably related to radiation in the 1.14--1.18 μm range from excited Na and K atoms contained in the flame. An increase in the incident radiation flux from $1.5 \cdot 10^2$ to $2 \cdot 10^3$ W/cm^2 causes no change in the steady value of the temperature of the glass and the quartz, which results from the phase transition. The temperatures of hetinax and textolite, after achieving a maximum value, decrease with time. This decrease probably results from the formation of a carbonized surface area, changing the coefficient of reflection and the heat conductivity of the material. The radiation capacity of these carbonized areas is practically the same as that of graphite for the same wavelengths and temperatures. Figures 4; references 9: 8 Russian, 1 Western.

THE SPECTRUM OF RADIATION OF A LASER AND CERTAIN PROPERTIES OF SPECTROSCOPY WITHIN THE CAVITY

GORCHARUK, I. M., KOTOMTSEVA, L. A., SAMSON, A. M.

[Abstract] A description is presented of the spectral form of quasisteady laser generation in the simplest case with a uniformly expanded amplification band. The primary factors influencing the spectrum are explained and the degree of change of the form of the contour upon insertion of a substance with a relatively narrow absorption band or amplification band into the cavity is estimated. The study is performed by means of balance equations for the populations of the operating levels of a 2-level active medium and transfer equations for radiation density, considering the spectral characteristics of the system. The equations derived allow the maximum permissible frequency-dependent deviations in loss coefficient not causing changes in the generation spectrum to be determined, thus indicating the sensitivity of the ruby laser to heterogeneity of its loss coefficients, Figures 3; references 17: 15 Russian, 2 Western.

CALCULATION OF THE WIDTH OF THE AREA OF SYNCHRONIZATION OF A RING LASER

TIMOFEYEVA, G. I.

[Abstract] The width of the area of synchronization of the oppositely directed waves in a ring laser is found and analyzed with arbitrary relationships between the phases of the coupling coefficients. Possible types of transition from single-frequency to double-frequency modes are considered. It is noted that at the boundary of the area of synchronization, the presence of coupling between oppositely directed waves does not cause a change in the lasing threshold, while the threshold within the synchronization area depends on the magnitude and phase of coupling. Figures 2; references 9: 8 Russian, 1 Western.

UDC 621.539.194; 541.61

NONLINEAR OPTICAL EFFECTS IN THE GENERATION OF HIGHER HARMONICS IN A
NEODYMIUM LASER IN ORGANIC MOLECULAR CRYSTALS

GAYLIS, A. K., KOLESNIKOV, V. A., SILIN'SH, E. A., Institute of Physics and
Power Engineering, Academy of Sciences, Latvian SSR

[Abstract] The nonlinear optical susceptibility of an organic crystal is
determined to a great extent by the structure and symmetry of the molecules
of which it is composed. A study is made of the nonlinear optical effects
in crystals of a number of derivatives of 1, 3-indanedione and molecular auto-
complexes. Over 120 different compounds were studied, including a group of
intramolecular salts—the betaines, sulfur-containing derivatives and
donor-acceptor compounds in which conjugation is transmitted through a
bridge, and enamines. Polycrystalline specimens of these compounds were
excited by a pulsed neodymium laser and the relative intensity of lasing at
the second and third harmonics was related to the intensity of lasing at
the corresponding harmonics of a standard compound, metanitroaniline, the
effectiveness of which was taken as 1. The greatest effectiveness was
observed for the betaines and sulfur derivatives. Nonlinear optical effects
can be maximized by selecting organic crystals consisting of molecules with
highly developed π-electron conjugation (polyconjugate aromatic and
heterocyclic compounds) containing polar radicals and heteroatoms which
disrupt the symmetry of the π-electron system, or heteroatoms with high
polarization properties such as S and I. Tables 2; references 15:
10 Russian, 5 Western.

UDC 621.373:535

NONLINEAR SHIFTING AND SPLITTING OF LASING FREQUENCIES OF COUNTER-
DIRECTED WAVES IN A RING LASER WITH A SPATIALLY HETEROGENEOUS MEDIUM

BOYTSOV, V. F.

[Abstract] A ring laser is analyzed, the resonator of which is a cylindri-
cal mirror with a uniform coefficient of reflection and two flat total-
reflection mirrors. All the mirrors are assumed large enough that diffrac-
tion can be ignored. Formulas are produced and analyzed for the nonlinear
frequency shift, proportional to the relative excess of pumping over the
threshold. It is demonstrated that in order to produce low levels of

splitting of lasing frequencies, resonators which are nearly confocal should be used, regardless of the ratio between effective transverse dimensions of the medium and resonator field. Frequency shift is independent of the tuning of the laser frequency from the center of the transition line. Frequency shift depends linearly on the dimensionless length of the laser tube, since the difference in the fields of the counter-directed waves is formed as a result of diffraction in the (heterogeneous) medium itself. References 9: 7 Russian, 2 Western.

LASER FREQUENCY DIFFERENCE OF ELLIPTICALLY POLARIZED COUNTER-DIRECTED WAVES IN A RING LASER IN A MAGNETIC FIELD

TIUNOV, YE. A. and FRADKIN, E. YE.

[Abstract] A ring gas laser is studied, which has arbitrary polarization anisotropy and contains no independent elements. A weak longitudinal magnetic field is applied to the active medium. Scalar equations for single-mode lasing are produced for this laser. These equations are used to generate an expression for the difference in lasing frequencies of the counter-directed waves in the case, important in practice, when their polarizations differ little and are near linear. This equation is analyzed for single- and dual-isotope composition of the gas. It is assumed that the gain is greater than the losses only for one type of oscillations, that with the highest Q, in each direction. Figure 1; references: 5 Russian.

THE STRUCTURE OF POLYMETHINE DYE MOLECULES AND THEIR LASER PROPERTIES

PRIZHONSKAYA, O. V. and TIKHONOV, YE. A.

[Abstract] The structural factors of molecules influencing their vibronic interactions and the shift between maximum bands of absorption and fluorescence, proportional to the vibronic interaction, are determined. Structural elements influencing the quantum yield of solutions of polymethine dyes are

also determined. The study was intended to optimize the parameters of lasers based on symmetrical polymethine dyes. It was concluded that the introduction of aromatic or heterocyclic substituents at the nitrogen atoms of heterocycles on the ends of conjugate chains allows the shape of the vibrational bands to be changed, increasing the half width and decreasing the overlap of absorption and fluorescence bands. This can significantly decrease the lasing threshold and increase the range of tuning of a laser. Changing of the terminal substituents changes the quantum yield in molecular dyes. Figures 2; table 1; references 22: 18 Russian, 4 Western.

EXISTENCE AND STABILITY OF A BEAT MODE AT RESONATOR FREQUENCY IN A RING LASER

FEDCHENYA, I. I. and KRUGLIK, G. S.

[Abstract] A ring laser is considered and the quantum equations of motion describing the dynamics of a signal due to interference between two opposing waves with a phase shift. On the basis of these equations, it is proved first that a beat mode at resonator frequency exists and then that such a mode can be asymptotically stable. The stability condition, based on Lyapunov's and Malkin's theorems, does not depend on the initial phase difference. References 8: 7 Russian, 1 Western.

KINETICS OF RADIATION EMISSION FROM SOLUTIONS OF COMPLEX ORGANIC COMPOUNDS AS A RESULT OF LASER PUMPING WITH LINEARLY POLARIZED RADIATION

PIKULIK, L. G. and YAROSHENKO, O. I.

[Abstract] Steady as well as pulse emission from a dye laser with transverse pumping linearly polarized and with the electric vector orthogonal to the resonator axis is analyzed, taking into account the anisotropic distribution of molecules but disregarding their Brownian motion. The fundamental

equations of kinetics have been derived from the equations of balance and one-dimensional energy transfer. Dye molecules are simulated by a linear oscillator, the same one for absorption and emission. The resulting system of first-order differential equations describes the polarization process and is solved here numerically by the Euler method, with the loss factor varied. The amplification characteristic, calculated in terms of maximum and minimum values, corresponds and thus reflects an anisotropy of emission too. According to the results of this analysis, linearly polarized pumping radiation which produces and sustains anisotropic distribution of molecules in the state of excitation will yield linearly polarized laser emission which opposes this effect and thus tends to reduce but cannot completely suppress such anisotropy. Figures 2; references 7: 5 Russian, 2 Western.

POLARIZATION-FREQUENCY CHARACTERISTICS OF ANISOTROPIC COMPOUND RING RESONATORS WITH ONE OR TWO COUPLING MIRRORS

LEDNEVA, G. P. and CHEKALINSKAYA, YU. I.

[Abstract] A method is shown of calculating the natural frequencies, the loss factors, and the intrinsic polarizations of compound ring resonators with any kind of anisotropy in both the active and the passive stage. This method is based on the plane-wave approximation and Jones matrices of wave transformation by an anisotropic device. According to the expressions derived here, generally two series of oscillation modes with different respective parameter values appear in each direction. The results are applied to a ring resonator with one coupling mirror and to a ring resonator with two coupling mirrors. On this basis are then analyzed the polarization and frequency characteristics of ring resonators with such anisotropic devices as a partial polarizer and a circular phase plate, or a partial polarizer and a Faraday rotator, or a Faraday rotator between two orthogonal quarter-wavelength plates (one principal axis of one plate in this nonreciprocal device at a 45° angle to the plane of the resonator). The active medium is assumed to be inside a tube with a Brewster window and the reflection coefficients of all reflectors in the passive stage, except that of a coupling reflector, are assumed to be equal to unity. Figures 2; references: 8 Russian.

DIELECTRIC COATINGS ON REFLECTORS FOR TWO-WAVE LASERS EMITTING AT 0.63 AND
3.39 μm WAVELENGTHS

POPOV, A. I., PROTSENKO, YE. D. and SKACHKOV, YU. F.

[Abstract] Helium-neon lasers emitting radiation at the infrared wavelength
$\lambda_{ir} = 3.39$ μm can be switched to the red wavelength $\lambda_r = 0.63$ μm by a
change of reflectors mounted on a revolver device or by means of compound
stationary reflectors with appropriately coated surfaces. The effectiveness
of such a compound set was studied experimentally, with the opaque reflector
having a coat of aluminum deposited on its inside surface. Both surfaces
of the output reflector were coated with different numbers of alternating
dielectric interference layers, the optical thickness of a layer corres-
ponding either to $\frac{1}{2}\lambda_r$ or to $\frac{1}{2}\lambda_{ir}$. The numbers of these layers, zinc
selenide and cryolite, were varied and the laser output power in both one-
wave modes as well as in the two-wave mode was measured. Also the effect
of angular misalignment of one reflector on the output power was measured
in each case. The results indicate that switching of a two-wave laser
does not appreciably affect the resonator adjustment. On this basis, one-
wave lasers LG-75 and LG-56 have been modified for operation in the two-
wave mode delivering approximately the same power of 1.5 mW at each wave-
length. Figures 4; references 18: 10 Russian, 1 German, 7 Western.

EFFECT OF THE DISPERSION OF THE ACTIVE MEDIUM ON THE EMISSION INTENSITY OF
A GAS LASER IN A LONGITUDINAL MAGNETIC FIELD

VOYTOVICH, A. P. and DUBOVETS, V. G.

[Abstract] A ring laser inside a resonator is considered and the matrix of
its active medium in a longitudinal magnetic field is calculated, with
transformation from Cartesion to polar coordinates. Components of the sus-
ceptance tensor are defined at the frequency of the resonator mode and
related to the relaxation parameters of a three-level quantum system. The
propagation of a plane electromagnetic wave along the resonator, the latter
first empty and then containing an active medium, is analyzed and the result-
ing emission intensity is calculated, with amplification as well as dispersion

of the active medium taken into account accordingly and assuming the radiation to be linearly polarized. Saturation due to the real part of susceptance is found to lower the emission intensity much more than do additional losses in the case of Zeeman splitting. In weaker magnetic fields the effects of both factors become equal, and they vanish in the absence of a magnetic field. Both factors also depend on the detuning, which can thus affect the stability range of one-mode and two-mode lasing. This feature can be used for mode selection. The authors thank P. A. Apanasevich for the discussion of the results. Figures 1; references 4: 3 Russian, 1 Western.

EFFICIENCY OF CO_2 EXCITATION IN A GAS-DYNAMIC LASER WITH GAS MIXING

OSTROUKHOV, N. N. and TKACHENKO, B. K., Moscow Physicotechnical Institute

[Abstract]   The characteristics of a gas-dynamic CO_2-laser were studied experimentally in the pulse mode, with nitrogen heating by hydrogen combustion in atmospheric oxygen. The efficiency of vibrational CO_2 excitation upon mixing with nitrogen in a supersonic nozzle would be indicated by the ratio of the number of actually excited molecules to the maximum number of molecules excitable with the same amount of vibrational energy without relaxation losses. This efficiency was measured in terms of gain at the center of the rotational line with $N_{001} \gg N_{100}$, regardless of the line broadening mechanism, as a function of the molar CO_2 fraction under various pressures. A lower estimate of this efficiency (gain), on the basis of measurements and assuming a negligible amplification at the walls where it cannot be measured, is 0.7-0.9% maximum. Figures 3; references 4: 3 Russian 1 Western.

A STATIONARY CLOSED-CYCLE CO$_2$-LASER RATED AT 6 kW FOR INDUSTRIAL PROCESSES

ARTAMONOV, A. V., YEGOROV, YU. A., KAZHIDUB, A. V., KATSURO, N. I.,
LEBEDEV, F. V., SIDORENKO, YE. M., SUMERIN, V. V. and FROLOV, V. M.

[Abstract] A stationary closed-cycle laser for industrial processes has
been developed which operates without expensive and scarce helium in the
active mixture. The latter consists of CO$_2$ and N$_2$ with air under a pressure
of 30 mm Hg. The optimum air content corresponds to a ratio of water to CO$_2$
concentration within the 0.1-0.15 range (optimum CO$_2$ concentration within
3-4%), depending on the air temperature and humidity. The equipment con-
sists of two parallel gas dynamic channels forming a closed loop through the
discharge chamber with a resonator, each channel including a compressor and
two heat exchangers with gas ducts. Both compressors are driven by a high-
speed (15,000 rpm) electric motor. The mixture is pumped in the discharge
chamber, where the electric current (up to 60 A) and the gas stream (up to
120 m/s) flow orthogonally to each other and to the optical axis. The
charging voltage varies from 2200 V across the first row of electrodes to
1400 V across the last row. Preliminary performance tests included measure-
ment of the amplification of a weak signal along the resonator axis and of
the output power as well as of the electrooptic conversion efficiency, all
as functions of the input power to the discharge column. An output power of
6 kW was obtained at a peak efficiency of 8%. According to estimates, the
efficiency can be doubled by using a longer discharge chamber and a multi-
pass resonator. The authors thank A. F. Vitshas and V. Ye. Gerts for
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the discussion and useful comments concerning the laser construction, also
V. P. Seleznev, P. N. Smirnov, M. M. Nikiforov, Yu. R. Terakopov, and
N. P. Shcherbakov for the assistance in setting up the equipment. Figures 3;
references 10: 4 Russian, 6 Western.

GENERATION OF NANOSECOND PULSES BY A CO_2-LASER OPERATING IN THE FREE-EMISSION MODE

ADAMOVICH, V. A., BARANOV, V. YU., SMAKOVSKIY, YU. B. and STREL'TSOV, A. P.

[Abstract] An experimental study was made to establish the feasibility of generating nanosecond pulses with a CO_2-laser operating in the free-emission mode. The active medium was ionized with an electron beam of 60 A/cm^2 current density and 300 keV energy. The energy of the laser radiation was measured calorimetrically, the pulse characteristics were measured oscillographically. Reducing the resonator length from 75 to 40 cm and increasing the pressure of the $CO_2:N_2:He = 4:1:8$ mixture to 3 atm yielded pulses of 7 ns duration, with an energy remaining almost constant over a wide range of the CO_2 pressure and proportional to it input energy. The authors thank V. D. Pis'mennyy, A. N. Starostin, and Yu. V. Petrushevich for the useful comments, also A. N. Alparov and R. K. Bekov for helping with the experiments. Figures 3; references 6: 4 Russian, 2 Western.

A SIMPLE AND RELIABLE ULTRAVIOLET LASER ON NITROGEN MOLECULES

ANTONOV, V. S., Institute of Spectroscopy at the USSR Academy of Sciences, Moscow

[Abstract] A modification of a nitrogen laser is proposed which ensures adequate stability and reliability as well as high efficiency and long life of miniature electrical components. The design features a discharge cell 85 mm long and 36 mm in diameter, with copper-tube electrodes moved away from the walls and toward each other symmetrically so as to leave an 18 mm wide discharge gap at the center and to produce a uniform discharge over a 60 mm wide active zone. The electrodes can be water cooled when the pulse repetition rate is high. The laser cell is mounted inside a resonator consisting of an opaque reflector with a quartz outlet window. The electric circuit includes a bank of four 10 nF - 40 kV capacitors in parallel, charged from a TG1-1000/25 high-voltage thyratron rectifier through a 20 μH inductance. While the thyratron fires, the charge transfers resonantly

from this capacitor bank to another one consisting of thirty 1 nF - 40 kV capacitors uniformly spaced along the laser cell so as to make the discharge circuit noninductive. The inductance of the thyratron circuit is 150 nH and thus prevents overloading, also eliminates the need for coaxial leads. The optimum nitrogen pressure is 25-40 mm Hg, depending on the charging voltage. A pulse of 4.5 mJ energy and 12 ns duration can be generated with a voltage of 25 kV. A maximum efficiency of 0.1% can be attained with a voltage of 10 kV. The laser beam through the quartz window has a 19x6 mm cross section. The author thanks A. N. Shibanov for the useful comments. Figures 5; references 8: 2 Russian, 6 Western.

ANALYSIS OF INHOMOGENEITIES INSIDE TRANSLUCENT MEDIA ON THE BASIS OF THE LASER RADIATION BACKSCATTER EFFECT

KIKIN, P. YU., SMIRNOV, YU. I., and KHANIN, YA. I., Institute of Applied Physics at the USSR Academy of Sciences, Gor'kiy

[Abstract] It has been demonstrated that scattering of light by inhomogeneities inside the volume of translucent media can be analyzed by measurement of the backscatter of laser radiation, with a helium-neon laser serving simultaneously as the light source and the backscatter indicator. This method was used for analyzing the backscatter in such a laser material as ruby grown by the Verneuil process and the ruby-leucosapphire composites. Both flat and cylindrical specimens with various degrees of defectiveness were tested, also patterns of anomalous birefringence were recorded. The authors thank I. L. Bershteyn for the useful comments. Figures 2; references: 6 Russian.

FEASIBILITY OF GENERATING SHORT LASER PULSES DURING PHOTOLYSIS OF A COOLED HYDROGEN-FLUORINE MIXTURE

BASHKIN, A. S., IGOSHIN, V. I., NIKITIN, V. YU., and ORAYEVSKIY, A. N., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The performance of an H_2-F_2 laser at a low initial temperature of the active medium has been analyzed and the conditions of the H_2-F_2 reaction established under which the latter peaks after the triggering stage. According to this study, such a laser-chemical process requires a mixture ratio H_2:F_2 = 1:3 under a pressure of 1/3 atm and at an initial temperature of 100 K, a triggering light pulse shorter than 4 μs and a concentration of active fluorine centers generated during photolysis n_F = 10^{18} cm^{-3}. A laser radiation pulse of 0.573 J/cm^3 energy and 60 ns duration can be generated in this manner. Figures 1; references 9: 8 Russian, 1 Western.

EMISSION FROM A HYBRID CO_2-LASER

LIKHANSKIY, V. V., MYL'NIKOV, G. D., NAPARTOVICH, A. P., SEMEROK, A. F., and SOBOLENKO, D. N.

[Abstract] A hybrid CO_2-laser has a high-pressure pulse-discharge chamber, a low-pressure steady-discharge chamber, and a resonator. Its characteristics and performance were studied under pressures of 150-760 mm Hg in the CO_2:N_2:He=1:1:0 chamber and 1-10 mm Hg in the CO_2:N_2:He=1:3:7 chamber. An analysis of the experimental results, on the basis of an emission model taking into account excitation exchange between N_2 and CO_2 molecules, reveals a stable longitudinal mode in the resonator at a sufficiently high gain in the low-pressure stage. A lower gain in the low-pressure stage results in an unstable one-mode emission with side modes. At a low gain in the low-pressure stage, down to zero, the emission becomes multimodal. By varying the gain, it is thus possible to regulate the delay of the emission pulse relative to the discharge current pulse in the high-pressure stage, depending also on the resonator parameters. Figures 3; references 12: 4 Russian, 8 Western.

POSSIBILITY OF SELF-FOCUSING DURING EVAPORATION OF A CLOUD BY CO_2-LASER RADIATION

SVIRKUNOV, P. N., Institute of Experimental Meteorology, Obninsk

[Abstract] Propagation of intensive radiation from a CO_2-laser through a mist fraction in the atmosphere is accompanied by heating and evaporation of droplets, followed by thermal defocusing and convective refraction with formation of high-translucence zones. It is demonstrated here theoretically that, in the case of a laser beam with a Gaussian radial profile, the refraction dynamics in such a zone may cause it to become self-focusing. The calculations are based on the equation of transient heat generation, with randomly distributed droplets constituting point heat sources of dimensions much smaller than the wavelength. The cloud is assumed to be stationary and most of the liquid mass to evaporate diffusively. The possibility of self-focusing is shown for a radiation wavelength $10.6\,\mu$ m and intensity 200 W/cm^2, spherical droplets of a radius $5 \cdot 10^{-4}$ cm at an ambient temperature $T_0 = 273$ K. With beam compression and increasing radiation intensity, defocusing will again occur. Figures 2; references 11: 8 Russian, 3 Western.

DESIGN OF MULTIPASS TELESCOPIC AMPLIFIER FOR CONTINUOUS-WAVE CHEMICAL HF-LASERS

VIRNIK, YA. Z., KRUTOVA, V. G., MASHCHENKO, A. I., ORAYEVSKIY, A. N., STEPANOV, A. A., and SHCHEGLOV, V. A., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The design of two telescopic amplifiers for diffusion HF-lasers is reviewed in the geometrical optics approximation. Both designs are based on multiple reflections by two cylindrical mirrors facing each other symmetrically, a smaller convex one and a larger concave one with a center aperture. In the first "inverted" version the radiation flux enters around the smaller convex mirror and is reflected by the larger concave one, leaving after several back-and-forth passes through the center aperture of the

concave mirror. In the second version the flux enters through the center aperture from behind the larger concave mirror and is reflected by the smaller convex one, leaving after several back-and-forth passes around the smaller convex mirror. The field distributions in the planes of both mirrors are derived by integrating the equations of flux transmission. Both designs are evaluated on the basis of performance characteristics, namely gain and chemical efficiency as functions of the incident flux intensity and as functions of the telescope magnification. Figures 4; references 11: 9 Russian, 2 Western.

USSR

EFFECT OF ATOMIC COLLISIONS ON THE SELECTIVITY OF RESONANT EXCITATION IN SEPARATION OF ISOTOPE MIXTURES

KARLOV, N. V., KRYNETSKIY, B. B., and MISHIN, V. A., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The selectivity of intrinsic laser action in separating isotope mixtures is diminished by resonant excitation exchange and charge transfer processes. Here the effect of resonant excitation exchange between isotopes, with atomic collisions, in dense atomic vapors is examined on the basis of the theoretical kinetic relations and experimental data obtained with a dye laser and a scanning Fabry-Perot interferometer. Such laser spectroscopy of metals with a natural complex isotope content, namely europium and samarium, requires close attention to overlapping absorption lines. The enrichment factor was also found to decrease rapidly with increasing atom concentration in the vapor. The authors thank V. A. Alekseyev for the useful comments and A. M. Prokhorov for the unwavering support of this study. Figures 5; references 9: 8 Russian, 1 Western.

LASER PHOTOLYSIS OF PERFLUOROALKYL IODIDES

YERSHOV, L. S., ZALESSKIY, V. YU., and SOKOLOV, V. N.

[Abstract] Quantum yields of metastable and unexcited iodine atoms are
important in the application of an iodine photodissociation laser. These
yields, within the range of continuous ultraviolet absorption bands, were
measured with a neodymium laser (1064 nm) and auxiliary optics by the
method of fourth-harmonic (266 nm) generation. The perfluoroalkyl
iodides CF_3I, $1-C_3F_7I$, and $(CF_3)_3CI$ were used in the experiment, after
multiple distillation and subsequent dilution in pure argon or sulfur
hexafluoride, Luminescence signals (1315 and 580 nm) were measured
oscillographically and, with these data, the concentrations of both kinds
of iodine atoms as well as of the radical and of iodine molecules were
calculated according to the equations of recombination and diffusion after
a laser pulse. The oscillograms are interpreted here qualitatively, and
the numerical results compared with those obtained earlier by others. The
authors thank A. M. Kokushkin for the interest as well as for the useful
comments and help in numerical computations. Figures 5; tables 1; refer-
ences 30: 17 Russian, 13 Western.

CONCENTRATION DEPENDENCE OF THE LUMINESCENT QUANTUM YIELD IN NEODYMIUM-
ACTIVATED LASER MATRICES AND ITS DETERMINATION FROM THE MICROSCOPIC
STANDPOINT

DENKER, B. I., OSIKO, V. V., PROKHOROV, A. M., and SHCHERBAKOV, I. A.,
Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Trivalent neodymium ions are the most widely used activators of
solid-state laser media. On the basis of the band structure of such an
ion, the mechanisms of nonradiative relaxation and annihilation from the
metastable $^4F_{3/2}$-state are considered, which depend solely on multipole

interaction between the Nd^{3+} ions and which determine the concentration
dependence of the luminescent quantum yield in crystals. The luminescence
quenching by the concentration effect is subsequently calculated by analyzing

the experimentally established relation from the microscopic view on energy transfer within an aggregate of interacting particles. The results should prove to be very useful in the search for new high-concentration laser media. Figures 3; references 56: 35 Russian, 21 Western.

MEASURING THE ELECTRONIC NONLINEARITY COEFFICIENT OF OPTICAL AND LASER GLASSES

BONDARENKO, N. G., YEREMINA, I. V. and MAKAROV, A. I., Institute of Applied Physics, USSR Academy of Sciences, Gor'kiy

[Abstract] The electronic nonlinearity coefficient, which determines the field-induced increment of the refractive index, is one of the principal parameters affecting the breakdown threshold of translucent dielectrics in power lasers. This electronic nonlinearity coefficient of several grades of glass (KGSS 1621, GLS 1, LG 247) and the critical power were determined by the self-focusing method with nanosecond pulses from a single-mode neodymium-glass laser, self-focusing being a manifestation of the threshold effect and the critical power depending on the effective (self-focusing) length of test specimens. Calculations based on these measurements of the pulse characteristics in this method assume a noninertial nonlinearity mechanism and a Gaussian field distribution in the laser beam. The authors thank V. A. Gaponov and V. I. Talanov for the useful comments. Figures 5; tables 1; references 11: 4 Russian, 7 Western.

STIMULATED RAMAN SCATTERING ON ROTATIONAL AND VIBRATIONAL TRANSITIONS IN GASEOUS NITROGEN

AVERBAKH, V. S., MAKAROV, A. I., and TALANOV, V. I., Institute of Applied Physics, USSR Academy of Sciences, Gor'kiy

[Abstract] The pressure thresholds of vibrational and rotational stimulated Raman scattering have already been estimated from available experimental

data on spontaneous scattering and gain calculations for the Stokes component. Gain increments within the low-pressure range, where splitting of components occurs, are now measured in a special experiment with a narrower spectrum, higher pumping power, and a more versatile receiver. The results, in terms of threshold characteristics and spectral characteristics of both scattering modes are reported here in more detail than at the Eighth All-Union Conference on Coherent and Nonlinear Optics in Tbilisi in May 1976. Figures 6; references 15: 3 Russian, 12 Western.

SHIFT OF THE λ = 3.39 μm TRANSITION FREQUENCY IN METHANE IN THE FIELD OF A RING LASER

BELENOV, E. M. and USKOV, A. V., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The hyperfine structure of the 3.39 μm methane line contains two faint components of different intensities and differently saturable in a laser field. This causes a saturation-dependent frequency shift in a gaseous ring laser. For the purpose of analysis of nonlinear power resonances and frequency stability in a helium-neon laser with a methane absorption cell, this shift of the center frequency is calculated here from a solution to the self-consistent system of equations describing the electric field intensity inside the resonator and the polarization of the active medium, with both represented as oppositely traveling waves. Figures 3; references 6: 4 Russian, 2 Western.

SHAPE OF THE FREE SURFACE OF THE LIQUID PHASE DURING MELTING OF HIGHLY ABSORPTIVE MEDIA BY LASER RADIATION

TRIBEL'SKIY, M. I.

[Abstract] In laser treatment of industrial materials, especially of highly absorptive ones such as metals with a radiation intensity of 10^6-10^7 W/cm^2,

it is necessary to consider transient melting and flow under the reaction pressure of vapor generated in the process. This problem is solved here analytically in the quasi-stationary approximation, assuming the laser pulses to be of a sufficiently long duration and the metal to be melting under vacuum. With the distribution of radiation intensity over the surface given, the temperature distribution over it is determined as well and, on this basis, the vapor pressure and the density of saturated vapor as functions of the temperature. The shape of the free surface and its oscillations are now calculated from applicable differential equations. The effect of deep melting on the surface deformation and the effect of the radiation intensity on evaporation of the material are each found to involve a transition threshold. Experimental and theoretical data for thirteen common metals do not quite agree, but oscillations of the free surface seem to always decay following a laser pulse, owing to attenuation of capillary waves and relaxation of reactive vapor pressure. The authors thank S. I. Anisimov, F. V. Bunkin, N. N. Rykalin, and A. A. Uglov for the discussion and helpful comments. Figures 2; tables 2; references 19: 15 Russian, 4 Western.

EXCITATION OF HIGH-PRESSURE LASER MEDIA WITH DISCHARGE THROUGH A DIELECTRIC

ISHCHENKO, V. N., LISITSYN, V. N., and SOROKIN, A. R., Institute of Semiconductor Physics, Siberian Division of the USSR Academy of Sciences, Novosibirsk

[Abstract] The energy characteristics of discharge through a dielectric are examined and, accordingly, the appropriate dielectric material is selected for exciting a high-pressure gaseous laser medium. Experiments were performed with CO_2 (CO_2-N_2) lasers under pressures up to 10 atm and with lasers on inert-gas transitions under pressures up to 17 atm, discharge through glass or fiberglass plastic material being effected by steep nanosecond high-voltage pulses coming from conventional capacitive pulse generators or from an oscillator with a saturable reactor across the tank circuit and the load. The latter scheme makes it feasible to attain a high E/p ratio, owing to the absence of preionization, and to regulate this ratio over a rather wide range. Figures 4; references 7: 6 Russian, 1 Western.

ELECTROSTRICTIVE BIREFRINGENCE INDUCED IN ISOTROPIC SOLID MATERIALS BY
INTENSIVE LASER RADIATION

DEMEN'YEV, A. S., MALDUTIS, E. K.,and SAKALAUSKAS, S. V., Institute of Semi-
conductor Physics, Academy of Sciences of the Lithuanian SSR, Vil'nyus

[Abstract] Analytical expressions are found for the deformation of an
isotropic solid material by electrostrictive forces that arise under the
action of an elliptically polarized axisymmetric laser beam. The steady-
state solution of the equation of equilibrium, with appropriate boundary
conditions and with the electrostrictive force averaged in time, is found
in the approximation of the plane stressed state. According to this analysis,
the electrostrictively induced change in the refractive index depends on the
polarization of the incident laser beam and, as long as it remains relatively
small, results in a birefringence pattern in the body with an attendant
depolarization of the transmitted laser beam. While the magnitude of the
electrostrictive birefringence effect is comparable to that of the Kerr
effect, depolarization of the laser beam can be caused only by electro-
striction or a thermal mechanism. Figures 4; references 19: 4 Russian,
15 Western.

EXPERIMENTAL DETERMINATION OF THE MAXIMUM PERMISSIBLE LEVELS OF PICOSECOND-
PULSE LASER RADIATION AT THE 1.06 μm WAVELENGTH

BEREZIN, YU. D., BAYANOV, V. I., GUDAKOVSKIY, YU. P., MURATOV, V. R.,
and SEREBRYAKOV, V. A.

[Abstract] An experimental study was made to determine the maximum permis-
sible levels of laser radiation, in terms of safety to the eye tissues, and
the dependence of these safe energy levels at λ = 1.06 μ m on the duration
of sub-nanosecond pulses. Eyes of chinchilla rabbits weighing 2.2-2.8 kg
were used as worst-case models of accomodation to infinity in this experiment,
with a helium-neon laser and appropriate shutters, filters, prisms, and
auxiliary optics, also a calorimeter and an opthalmoscope. The threshold
was taken as the minimum detectable change in the retina immediately after
irradiation. Laser pulses were recorded on oscillograms and chronograms.

Based on a statistical evaluation of the test data, the probability of threshold damage was plotted as a function of the pulse-train energy, in the form of histograms and regression lines. According to the results, the maximum safe energy of laser pulses at the given wavelength is $2.6 \cdot 10^{-5}$ and $1.5 \cdot 10^{-5}$ J/cm^2 respectively in the case of a 130 ns train of 100 ps pulses and in the case of a single 100 ps pulse. While the hypothesis of thermal interaction between laser radiation and the biological eye structures appears to be correct for subnanosecond pulses, the mechanism of threshold action by shorter pulses may be a different one. Figures 3; references 9: 5 Russian, 4 Western.

LASER-RADAR MEASUREMENT OF WIND VELOCITY BY THE METHOD OF SPATIAL FILTERING

VINTSLAV, G. YE., GUSAROV, V. P., KOSTKO, O. K., KRAVETS, O. K., SUKHOVOL'SKIY, V. M., and KHOLODOV, YU. V., Central Aerological Observatory, Moscow

[Abstract] Wind velocity measurement with a laser-radar instrument is proposed which involves frequency processing of the photocurrent spectrum, this spectrum resulting from an intensity modulation of scattered laser radiation by movement of the image of a spatial inhomogeneity across the raster. Theoretically this method is based on filtration of fluctuations due to intensity contrast only, inasmuch as laser radiation ceases to be coherent upon being scattered by aerosol particles in continuous Brownian motion and, therefore, interference effects vanish. The method was tested with an LG-36A helium-neon laser and an MTO-1000 optical radar receiver antenna in two series of measurements: one in a dynamic wind tunnel for calibrating the laser-radar, another in the free atmosphere for determining the fluctuations of wind velocity at a reference distance from the instrument. With the use of suitable lasers, it is possible to extend the range of measurements to hundreds of metres. The authors thank Ch. D. Zichenkov and V. I. Dovbishchuk for helping perform the tunnel experiments. Figures 5; tables 1; references 12: 7 Russian, 5 Western.

CONTINUOUS-WAVE DYE LASER WITH FREQUENCY TUNING BY MEANS OF A HOLOGRAPHIC DIFFRACTION GRATING

BALYKIN, V. I., MISHIN, V. I., and SEMCHINEN, V. A., Institute of Spectroscopy at the USSR Academy of Sciences, Moscow, KLOSE, E., Central Institute of Optics and Spectroscopy, Academy of Sciences of the German Democratic Republic, Berlin

[Abstract] A continuous-wave dye laser is considred which operates with a combination of semitranslucent reflector and holographic diffraction grating for wavelength selection over the entire visible range. Such a diffraction grating can be regarded as a Fabry-Perot etalon with one narrow-band reflector, its maximum reflection coefficient corresponding to antiresonance. The performance of such a selector is compared to that of a conventional selector consisting of two prisms and a Fabry-Perot etalon. The emission characteristics of this selective laser are compared with those of a non-selective laser, in terms of losses and gain as well as output power to pumping power ratio. Experimental data were obtained with a laser on rhodamine 6G and a diffraction grating having 2040 lines/mm (reflection of the $E_\perp$-mode at the 580 nm wavelength $R_0 = 85\%$ in the first-order spectrum). The authors thank V. S. Letokhov and Ye. N. Antonov for the useful comments, also S. Poltze for supplying the holographic diffraction grating. Figures 5; references: 10 Western.

A METHOD OF PRODUCING POLARIZED PROTONS BY LASER RADIATION

LETOKHOV, V. S., LOBASHEV, V. M., MINOGIN, V. G. and MISHIN, V. I., Institute of Spectroscopy, Academy of Sciences USSR

[Abstract] The authors consider the feasibility of producing an intense beam of high-energy polarized protons. The approach is based on combining the techniques of optical orientation of atoms in circularly polarized light and selective photoionization of atoms by laser radiation. The proposed scheme involves extinction of hydrogen atoms from the $2S_{1/2}$ state assuming selectivity with respect to projections of the total momentum,

followed by effective ionization of atoms with a certain momentum projection via the Rydberg state. At the current level of tunable laser technology such an approach should yield a beam of polarized protons with nearly 100% nuclear polarization and an angular aperture of less than 0.2 radian comprising very nearly 25% of the polarized protons from the total number of atoms in the metastable $2S_{1/2}$ state. The proposed method is applicable for producing polarized ions of other elements than hydrogen. The authors thank Professor I. I. Sobel'man for constructive criticism. Figures 2; references 4: 3 Russian, 1 Western.

DANELYUS, R., DIKCHYUS, G., KABELKA, V., PISKARSKAS, A., STABINIS, A., YSEVICHYUTE, YA., Vil'nyus State University imeni V. Kapsukas

[Abstract] Theoretical and experimental research is reported on parametric amplification and stimulated parametric scattering (parametric superluminescence) of light in fields of picosecond stimulation pulses. Crystals of ADP, MKP, α-HIO_3, $LiIO_3$ and $LiNbO_3$ were studied. The fundamental, second, third and fourth harmonics of emission from a YAG:neodymium monopulse laser were used for pumping. The efficiency of converting radiation to parametric superluminescence reached 15% with spectral width of the superluminescence line of 4-8 cm^{-1}. Picosecond emission is tunable in a range of 300-4800 nm, the power of the parametric superluminescence varying from 1 to 17 MW. Pulse duration is 6-30 ps depending on conditions. Light amplification with respect to energy was 10^5 in MKP and α-HIO_3 crystals. This high gain enables more accurate measurements of the time envelopes for picosecond pulses by stroboscopic methods than by conventional nonlinear optics methods. A picosecond parametric spectrometer is developed to handle a wide range of problems in the spectroscopy of picosecond processes in atoms and molecules. The technique of stimulating tunable parametric superluminescence in the picosecond range opens up possibilities for precision measurements of fast photoinduced processes in biological objects without destruction of molecules. Figures 7, references 19: 11 Russian, 8 Western.

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CHARACTERISTICS OF LASER GLASSES

AVAKYANTS, L. I., BUZHINSKIY, I. M., KORYAGINA, YE. I., and SURKOVA, V. F.

[Abstract] Glass activated with neodymium Nd^{3+} ions is the most widely
applicable material for solid-state lasers. All 26 Soviet grades and 29
foreign grades (made by American, West German, Japanese, and French manu-
facturers) surveyed in this report fall into the two categories of silicate
and phosphate glasses. Their physico-chemical and optical properties as
well as radiation and luminescence characteristics are tabulated. The
spectral distribution curves of their optical density are given in the form
of graphs. Discussion of these data covers the methods of measurement and
calculation, also applicable standards including laser emission and perform-
ance parameters of these glasses. Figures 6; tables 9;references 131:
115 Russian, 16 Western.

UDC 621.378.33

EFFECT OF LASER RADIATION ON THE ADHESION OF ELECTRONS TO MOLECULES

BETEROV, I. M., CHEBOTAYEV, V. P., FATEYEV, N. V., and YAKOVIN, D. V.,
Institute of Semiconductor Physics, Siberian Division of the USSR Academy of
Sciences, Novosibirsk

[Abstract] An experimental study was made which revealed the effect of
laser radiation on the formation of negative ions in sulfur hexafluoride.
Into a cell was pumped molecular SF_6 gas and through it was passed radiation
from a CO_2 laser, with an electron collector and a ion collector in addition
to the cathode mounted inside the cell. For the purpose of separating the
ion component of the current of negatively charged particles from the elec-
tron component, a longitudinal magnetic field was applied by placing the
cell inside a solenoid. For the purpose of extracting the signal component
due to the laser radiation, the latter was chopped mechanically at a frequency
of 130 Hz. The current of negative ions was found to peak sharply at an SF_6
pressure slightly above 0.1 mm Hg, at which an alternating component due
to the laser radiation appeared. The latter peaked sharply at an SF_6 pres-
sure slightly above 0.2 mm Hg and vanished at a not much higher pressure.
These results are interpreted in terms of collision and adhesive dissociation

mechanisms, explaining the strong dependence of the adhesion coefficient on the electron energy. The sensitivity of the adhesion effect to the energy of vibrational excitation can be utilized for laser separation of isotope mixtures with electronegative features. Figures 2; references 6: 2 Russian, 4 Western.

ONE POSSIBILITY OF GENERATING OPTICAL PICOSECOND PULSES OF TUNABLE FREQUENCY AND VISIBLE OR ULTRAVIOLET WAVELENGTHS

SARKISYAN, D. G., Institute of Physics Research, Academy of Sciences of the Armenian SSR, Ashtarak

[Abstract] It has been demonstrated that, by excitation of the continuum in such a medium as D_2O or H_2O with a subsequent addition of its frequency and the frequency of a laser in a crystal such as $LiIO_3$, one can generate radiation of 1-5 MW power which is tunable over the 330-700 nm range of wavelengths. Spectral analysis of this radiation has revealed that within the 480-550 nm range this radiation occurs on a single line not wider than 40 cm^{-1}. Within both other ranges, 330-480 nm and 550-700 nm, this tunable radiation splits into two lines not wider than 20 cm^{-1} each. In this case to every frequency on one side of the center frequency there corresponds a conjugate frequency on the other side, and addition of both satisfies the condition of phase synchronism. When radiation with a continuous spectral band and some center frequency enters a nonlinear crystal, then all conjugate frequencies will add pairwise simultaneously while the second harmonic of that center frequency is emitted. As a result, the original frequency band is transformed in the nonlinear crystal to a much narrower frequency band at a higher level. The spectrum of the converted radiation depends on the dispersion of the medium and on the geometry of the interaction space. The author thanks professor M. L. Ter-Mikayelyan and R. N. Gyuzalyan for the useful discussion of the results. Figures 5; references 11: 6 Russian, 5 Western.

NONLINEAR PROPAGATION OF LASER RADIATION THROUGH SOLID AEROSOL

ZAKHARCHENKO, S. V., PINCHUK, S. D., and SKRIPKIN, A. M., Institute of
Experimental Meteorology, Obninsk

[Abstract] An experimental study was made of aerosol transillumination with
a laser beam. The aerosol consisted of solid corundum particles with low
absorptivity. A neodymium glass laser operating in the free emission mode
was used, generating pulses of up to 10^3 J energy and 1μ s duration at the
1.06μ m wavelength. The radiation intensity was varied from 10^2 to 3 W/cm^2
at a constant pulse width. Both incident and transmitted radiation were
recorded with photodiodes through neutral and interference filters. An
analysis of the results reveals glow and motion of aerosol particles within
the region traversed by the laser beam. Heating of particles by the absorbed
optical radiation is the most likely cause of this phenomenon, with addi-
tional attenuation of the radiation intensity due to scattering by thermal
aureoles occurring at higher temperatures below the melting point. The
radiation intensity necessary for heating corundum aerosol to the melting
point is calculated here theoretically on the basis of the energy balance.
The authors thank V. Yu. L'vov and L. G. Akul'shina for the help, also
P. N. Svirkunov for the useful discussion. Figures 3; references 12:
11 Russian, 1 Western.

PERIODIC-PULSE OPERATION OF A CF$_4$-LASER WITH OPTICAL PUMPING AND AN AVERAGE
EMISSION POWER OF 0.2 W

BARANOV, V. YU., VASIL'YEV, B. I., VELIKHOV, YE. P., GOROKHOV, YU. A.,
GRASYUK, A. Z., DYAD'KIN, A. P., KAZAKOV, S. A., LETOKHOV, V. S.,
PIS'MENNYY, V. D., and STARODUBTSEV, A. I., Institute of Spectroscopy at the
USSR Academy of Sciences, Moscow, Institute of Physics imeni P. N. Lebedev,
USSR Academy of Sciences, Moscow

[Abstract] An experimental study was made to establish the feasibility of
generating pulses at a high repetition rate and thus high average power with
a CF$_4$-laser. Pumping was by a CO$_2$-laser generating 100 ns wide periodic

pulses of up to 5 J energy at a repetition rate of up to 200 Hz. The optics consisted of two diffraction gratings and a laser resonator with opaque mirrors. The output energy was measured as a function of the pumping energy at a pulse repetition rate of 4 Hz and found to increase linearly. It was also measured as a function of the CF_4 pressure at a pulse repetition rate of 5 Hz and found to peak sharply at approximately 2 mm Hg. On the basis of diffusion estimates, transition from single-pulse to periodic-pulse operation of such a laser is possible at a repetition rate of 5 Hz. At higher repetition rates the diffusion time becomes shorter than the interval between two successive pumping pulses and the gas begins to heat up. Its temperature rise is estimated here theoretically, on the assumption of a cylindrical laser beam with a Gaussian intensity distribution. The repetition rate can be increased by repumping the gas so fast as to replace the entire mass in the cell during the interval between two successive pulses. An average emission power of 200 mW at a pulse repetition rate of 100 Hz was attained even without gas repumping. The authors thank R. V. Ambartsumyan and N. P. Furzikov for the useful comments. Figures 4; references 6: 3 Russian, 3 Western.

Magnetohydrodynamics

AN AUTOMATIC SYSTEM FOR MEASURING THE CONCENTRATION OF SEEDING ATOMS IN
AN MHD-GENERATOR

NEFEDOV, A. P. and URINSON, A. S.

[Abstract] The parameters of a cold plasma stream vary over the channel
section. In an MHD-generator the wall temperature is much lower than the
plasma temperature and, furthermore, varies in the axial direction so that
self-reversal of the resonance lines of alkali metals used for plasma diag-
nostics can occur. This has already been utilized for determining the con-
centration of easily ionizable seeding atoms. In order to determine their
concentration, it is necessary to know not only the plasma temperature and
pressure but also the thickness of the emitting layer and the plasma non-
homogeneity parameter. Here an experimental apparatus is shown which con-
sists of an ISP-51 spectrograph with a UF-89 camera, a spectral plasma
thermometer, a pressure transducer, a reference radiation source, an inte-
grating amplifier, a recording instrument, a control panel, and a computer
with a teletypewriter. The computer automatically either calculates the
concentration of atoms from the independently recorded and measured center-
to-peak distance in the resonance line, or by also first processing the con-
tour of the resonance line. The error is in both cases within 25-30%.
Typical results are shown which have been obtained in an experiment with an
MHD generator heated by natural gas and using K_2CO_3 as ionizable additive.
Figures 3; tables 1; references 6: 4 Russian, 2 Western.

POLAND

ON-LINE TESTING IN NUCLEAR FUEL REPROCESSING

PARUS, J., KIERZEK, J. and ZOXTOWSKI, T., Institute of Nuclear Research, Warsaw

[Abstract] The reprocessing of spent nuclear fuel is primarily a chemical process and its testing should reflect the trends of development in the chemical industry. This article therefore analyzes trends in the development of methods of control of chemical processes and continuous analytical devices. The specifics of methods of on-line testing in the reprocessing of spent nuclear fuel are discussed. This review also covers pH measurement, spectrophotometers, mass spectrometry, liquid chromatography, gas chromatography and other methods of continuous measurement, the general characteristics of on-line measurement methods, radiometric methods, measurement of alpha radiation, gamma radiation and X-ray fluorescence, methods based on neutron radiation measurement, physical-chemical methods, methods not requiring the addition of reagents, as well as methods which do require their addition. The latest trends in process control based on dynamic process models are also presented. References 72: 9 Russian, 13 East European, 50 Western.

ELECTRONIC COOLING AND NEW POSSIBLE APPLICATIONS IN PHYSICS OF ELEMENTARY
PARTICLES

BUDKER, G. I. and SKRINSKIY, A. N., Institute of Nuclear Physics, Siberian
Division of the USSR Academy of Sciences, Novosibirsk

[Abstract] According to the Liouville theorem, the density of a beam of
elementary particles in the six-dimensional ("generalized coordinates--
conjugate momenta") phase space is invariable and determined by the initial
conditions. Focusing or acceleration, or any combination of both, can only
alter the shape of the phase volume and perhaps decrease the effective
phase density, but increasing the phase density is possible only by means
of dissipation. Friction, for instance, will inhibit vibration of particles
and their deviation from equilibrium motion. This principle has been
applied to electronic cooling of proton beams. The choice of mode of
electron acceleration and subsequent injection into the beam of heavy
particles depends on the energy level, electrostatic rectilinear acceleration
being appropriate for low energy levels and magnetic closed-path accelera-
tion being more appropriate for higher energy levels. It is important to
maintain a low effective electron temperature over a long cooling path and
to compensate for the nonuniform radial distribution of electron energy in a
beam. The kinetics of electron cooling can be analyzed best in the most
basic and important case of a single-pass electron beam. Such an analysis
takes into account the effects of electron-proton interaction, in the form
of collisions and scattering, on friction and on damping of proton vibrations
as well as on random diffusive dispersion of proton momentum and on elec-
tron entrapment with resulting recombination. It also takes into account
proton-proton interaction in the form of internal scattering of protons by
protons within the proton beam. An experimental study of electron cooling
was made with a special proton and antiproton accumulator, after a great
deal of engineering development and design. The results have so far yielded
much information about proton beams and the effects of electronic cooling.
They also have established the feasibility of accumulating high-intensity
antiproton beams, particularly with hyperfine internal gaseous or vaporous
targets, of accelerating these antiprotons, of continuously cooling opposed
proton and antiproton fluxes, of producing proton-antiproton interaction at
extremely low and at extremely high energy levels. It appears feasible,
furthermore, to generate antiatom beams (atoms of antihydrogen), antideuteron
beams, and polarized antiproton beams. The authors thank Ya. S. Derbenev,
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ELECTRONIC COOLING

BUDKER, G. I. (deceased), Institute of Nuclear Physics, Siberian Division
of the USSR Academy of Sciences

[Abstract] Experiments with opposed high-energy beams of elementary par-
ticles provide much basic information sought in modern physics research.
The gist of these experiments is to produce narrow and monochromatic beams
with a small phase volume, by damping out both longitudinal and transverse
vibrations of particles. This cannot be achieved by any external force,
according to the Liouville theorem, but only by dissipation forces such as
friction. The "electronic cooling" method had been proposed in the nineteen
sixties for application to opposed beams of heavy particles (protons or
antiprotons). Here along such a beam is injected a beam of electrons with
the same mean velocity. The efficiency of electron scattering by protons
is inversely proportional to the fourth power of the relative velocity of
interacting particles. With the mean velocities of both being equal in this
case and their difference thus equal to zero, the scattering cross section
depends now on the velocity dispersion. If the relative velocity dispersion
in the electron beam does not exceed 10^{-3} and the mean velocities of protons
and electrons coincide within the same limits, then a scattering cross sec-
tion 12 orders of magnitude larger than with a cluster of free electrons can
be attained. Experiments based on implementation of this principle were
subsequently performed in the early nineteen seventies. Recombination pro-
cesses in a two-component plasma produced during cooling were, furthermore,
found to result in a narrow-angle monochromatic beam of neutral particles.
The effectiveness of this method and the validity of its principle have been
confirmed by the author (G.I. Budker), Ya. S. Derbenov, N. S. Dikanskiy,
I. N. Meshkov, V. V. Parkhomchuk, D. S. Pestrikov, R. A. Salimov, A. N.
Skrinskiy, and B. N. Sukhina. These experiments, performed with proton beams
from 1.5 to 85 MeV, have provided a great deal of information about thermal
effects and nuclear photoemission as well as about the feasibility of anti-
proton generation and accumulation.

EFFECT OF NEUTRON AND GAMMA IRRADIATION ON THE CATHODOLUMINESCENCE SPECTRA
OF EPITAXIAL DIODE STRUCTURES ON $Al_xGa_{1-x}As$

BRZHEZINSKIY, V. A., DOBRYNINA, YE. S., PETROV, V. I., and CHUKICHEV, M. V.

[Abstract] A study was made concerning the effect of neutron and gamma
irradiation on radiative recombination in $Al_xGa_{1-x}As$ solid solutions on
GaAs-Zn substrates. Both "direct" and "indirect" radiating p^+(GaAs-Zn)-p-
($Al_xGa_{1-x}As$-Zn)-n($Al_xGa_{1-x}As$-Te) heterostructures were produced for this
experiment by the method of twofold liquid-phase epitaxy. The specimens were
irradiated in a pulse reactor with a neutron flux of 1.6 MeV mean energy
($E_{min} \geq 0.1$ MeV) and a 10^{14} neutrons/cm^2 density as well as with 10^8-10^9 R
doses of gamma quanta. Cathodoluminescence was excited and examined under a
raster-type JSM-50A electron microscope. The results indicate an overall
decrease of cathodoluminescence intensity after irradiation and selective
quenching of the low-energy band associated with recombination through zinc
levels. This is attributed to a definite kind of defects which form as a
result of irradiation and become annealed at a fairly low temperature.
Figures 2; references 5: 3 Russian, 2 Western.

THE RESONANT NONLINEAR OPTICS OF GAS SYSTEMS

POPOV, A. K.

[Abstract] One of the most important tasks of nonlinear optics is that of expanding the range of frequencies in which coherent radiation can be produced. The use of nonlinear processes in gas media is promising for the solution of the problem. Due to the low concentration of active particles in gas media, high levels of pumping power must be used to achieve high conversion factors, though the use of resonant and quasiresonant nonlinear processes does hlep. This literature review indicates that these processes have already resulted in the creation of devices, but the further development of this branch of nonlinear optics will require a deepening of our understanding of strong field resonant nonlinear effects such as phase capture, self-focusing and self-curvature of radiation under conditions of two-photon resonance, nonmonochromatic effects and dispersion, and coherent effects. With pumping by short, powerful pulses, the development of non-linear processes is significantly influenced by cooperative processes in the system of atoms or molecules. An increase in nonlinear susceptibility can be achieved in many cases by the use of radiative collisions. Figures 5; references 92: 50 Russian, 42 Western.

LASER MOLECULAR SPECTROSCOPY. DETERMINATION OF PARAMETERS OF THE VIBRATIONAL-ROTATIONAL LINE asR (1,1) OF THE ν_2 BAND OF AMMONIA IN AN ATMOSPHERE OF FOREIGN GASES

BULANIN, M. O., BULYCHEV, V. P., LADVISHCHENKO, YU. M., KHODOS, E. B.

[Abstract] A study is made of the absorption of the radiation of a CO_2 laser in the 10.6 μ m band by ammonia in mixtures with N_2, H_2, Ne, Ar, Kr and Xe. In the experimental installation, the CO_2 laser, resonator length 150 cm, is carried by a framework of heat-insulated invar rods. Absorption was measured with various pressures of the foreign gases. The experimental data were used to determine the spreading and shifting of the asR (1,1) line of the ν_2 band of N^{14} ammonia. A modified Lorentz function was used to

describe the absorption line. Particular attention is given to the effects of the noble gases. Figures 2; tables 3; references 15: 2 Russian, 13 Western.

PARAMETRIC PICOSECOND SUPERLUMINESCENCE OF LiIO$_3$ CRYSTALS

ARUTYUNYAN, A. G., ARZUMANYAN, G. M. and SHARKHATUNYAN, R. O., Yerevan State University; DANELYUS, R., KABELKA, V. and YASEVICHYUTE, YA., Vil'nyus State University imeni V. Kapsukas

[Abstract] Parametric superluminescence of ultrashort light pulses in LiIO$_3$ crystals was studied both theoretically and experimentally. The fundamental interaction equations involving the envelopes of three waves were solved numerically on a high-speed digital computer. Measurements were made using a YAG:Nd^{3+} laser with self-mode locking, a Fabry-Perot resonator with one fully reflective and one semireflective mirror, a second-harmonic generator on a KDP crystal, an LiIO$_3$ parametric oscillator, an LiIO$_3$ parametric amplifier, a photodiode, and appropriate auxiliary optics including a filter. Pumping with pulses at the 532 nm wavelength yielded superluminescence pulses of five times shorter duration, close to 6 ps, and smoothly tunable over the 608-4250 nm range. After spatial and frequency filtration, the spectrum of parametric superluminescence was found to be still very wide in the degenerate mode ($\Delta \lambda_{psl}$ = 12 nm in the 1064 nm band), but to narrow down farther away from this mode ($\Delta \lambda_{psl}$ = 1 nm in the 900 nm band). An emission power of 1 MW was attained, at an energy conversion efficiency of 2%. The results indicate that LiIO$_3$ crystals, with such a high energy conversion efficiency and such an extremely narrow emission spectrum, tunable over a wide range down to infrared wavelength, are very suitable for application in spectroscopy. Figures 5; references 18: 10 Russian, 1 German, 7 Western.

RING METHOD OF RECORDING THE SCATTERING INDICATRIX IN A DIFFRACTION
STRUCTUROMETRE

USHAKOV, V. V.

[Abstract] Conventional diffraction structurometres for analyzing polydis-
perse media operate by the method of small angles and record the diffraction
pattern in the focal plane of the receiver lens inside the diaphragm, with
the photoreceiver (photomultiplier) at the focal distance behind. The mag-
nitude of the useful signal generated here decreases rapidly with increasing
diffraction angle, inasmuch as the scattering indicatrix is very forward
elongated. Two features of a laser beam, its only slight divergence and
small diameter, can be utilized to make such an instrument more accurate
and sensitive. The solid angle which subtends the laser beam entering the
diaphragm should increase with increasing diffraction angle so as to com-
pensate the signal attenuation due to elongation of the indicatrix. This
is achieved by placing an annular diaphragm of opaque material directly
on the outside flat cathodic surface area of the glass envelope of the
photomultiplier. With the narrow laser beam aimed at the center of this
diaphragm, the diffraction angle is varied by moving the photomultiplier in
the envelope along the beam. Figures 3; references: 3 Russian.

CONTINUOUS RADIATION SPECTRUM OF A HELIUM PLASMA

VOLKOV, A. N., GIPPIUS, YE. F., and KOLESNIKOV, V. N.

[Abstract] Absolute intensities of the continuous radiation spectrum of a
highly ionized helium plasma were measured over the 180-710 nm range of
wavelengths (visible and ultraviolet). These measurements involved also a
determination of the plasma parameters, namely its ion content as well as
electron concentration and electron temperature. Both a VMR-2 monochro-
mator and a 512-channel LP-4050 pulse analyzer were used for the 180-290 nm
part of the spectrum, with UFS-1 and UFS-2 optical filters for reducing the
level of scattered light. Discharge in spectrally pure helium under a pres-
sure equal to 3 mm Hg inside a quartz tube 28 cm long and 1 cm in diameter

was produced at an ignition voltage of 10 kV with a bell-shaped current pulse of 45 A amplitude and 8.5 μs base width. Intensity calculations for the entire range of the spectrum are found to agree closely with the experimental data, except in the regions preceding the cutoff frequencies ([1.0-1.3]·10^{15} 5^{-1} in the recombination spectrum of He-II, and [0.68-0.82]·10^{15} 5^1 in the spectrum of He-I), where the measured intensities are appreciably higher than the theoretical values. The authors thank N. N. Sobolev for the interest and the discussion of the results, also A. M. Urnov for the help in calculating the cross sections. Figures 2; references 10: 8 Russian, 2 Western.

AN INTRACAVITY SPECTROMETER WITH A CONTINUOUS-JET DYE LASER

ADAMUSHKO, A. V., BELOKON', M. V., and RUBINOV, A. N.

[Abstract] An intracavity spectrometer is described which combines a high sensitivity with a fine spectral resolution. It consists of an argon laser pumping a continuous-jet dye laser, a scanning interferometer and a wedge interferometer, a resonator cavity between three spherical mirrors, a discharge tube, another mirror, a modulator, a monochromator, a photoreceiver, a synchronous detector, and a recording instrument. The spectrometer was successfully used for measuring and analyzing absorption spectra, after calibration against the lines of high excitation levels in orthohelium. Figures 3; references 15: 7 Russian, 8 Western.

RADIATION CHARACTERISTICS OF THE ZONE OF INTERACTION BETWEEN HYPERSONIC PLASMA FLOWS AND BARRIERS IN THE VACUUM ULTRAVIOLET REGION

KOZLOV, N. P., MALASHCHENKO, V. A., and PROTASOV, YU. S.

[Abstract] In a search for efficient plasmatic sources of vacuum-ultraviolet radiation, the energy characteristics of the plasma focus inside an erosion-type magnetic plasma compressor were measured within the range with

an open binary inert-gas ionization chamber. Hypersonic streams of dense plasma were generated within the cylindrical vacuum space 3 m long and 0.5 m in diameter under a residual pressure of 10^{-5} torr. Discharge in Teflon-4 was produced by a current pulse of 500 kA amplitude and 20 μs width through copper electrodes from a 750 μF capacitor charged to 5 kV. According to the results, axial confinement of supersonic plasma streams in such a compressor by means of immovable barriers can increase by a factor of 1.3-3 the efficiency of energy conversion, from electric energy stored in capacitors to radiation energy in the far vacuum-ultravioltt range corresponding to h ν = 10-70 eV. Figures 3; references: 5 Russian.

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ROLE OF THE PIEZO-OPTIC EFFECT IN THE DYNAMICS AND THE SPECTRAL DISTRIBUTION
OF RADIATION FROM A LASER WITH AN ELECTRO-OPTIC SHUTTER

KOVALEV, A. A., RAZVIN, YU. V., TYUSHKEVICH, B. N. and SERAK, S. V.

[Abstract] An experimental study was made of the piezo-optic effect as well
as of its role in the dynamics and the spectral distribution of radiation
from a ruby laser with an electro-optic shutter. The latter, a reflector
made of a KDP crystal, was controlled by a high-voltage pulse with a steep
leading edge and an exponential trailing edge. It was possible to eliminate
additional pulses following the main monopulse and to increase the energy of
the latter to approximately 0.2 J, by increasing the amplitude of the control
pulse to the shutter so as to raise the pumping level higher than 30% above
the threshold and to narrow the radiation spectrum to approximately 2.5·
10^{-3} cm^{-1}. The reflection coefficient of the shutter was then found to be
maximum at the beginning of the control pulse and only continue, due to the
piezo-optic effect, to fluctuate with decreasing amplitudes. Figures 2;
references 7: 6 Russian, 1 Western.

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